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COMPARATIVE STUDY OF CHEMICAL AND MECHANICAL METHODS OF WEED CONTROL ON THE YIELD OF MAIZE.

J. P. Sharma, R. R. Singh and G. B. Singh.

In India Weed Control in maize crop has been mainly through mechanical methods. These may adversely affect the crop growth because of their root pruning effects, and in larger holding may become expensive. It is now being recognised from work done abroad that the total number of mechanical operations can be reduced if suitable herbicides are employed to control weeds.

Chemicals used for weed control in maize are many. But to be successful, the maize plants should have tolerance to the weedicides. The tolerance of the maize plant to 2, 4-D sodium salt, 2, 4-D acetamide, crag herbicide, trichlorobenzoic acid and Dinitro-ortho-Sec-butyle phenol at certain concentrations, varying according to the age of the plant, has been reported to be good. Weed competition in maize is more vigorous in early stages than at advanced age. Sprayings at early stage may help solving this problem. Cultivation at later stages may provide aeration and better tilth in soil as this period coincides with incidence of heavy rain, and they also check the growth of late germinating and resprouting weeds in the sprayed plots. Thus, there appears to be a scope for pre-emergence and emergence weed control treatments supplemented with cultivations at later stages. Adoption of chemical weed control in conjunction with cultivation may become a feature of maize husbandry in future years.

Methods and Materials.

Five chemicals, 2, 4-D sodium salt, 2, 4-D acetamide, crag herbicide, Trichloro benzoic acid and general weed killer (Dinitro-ortho-Sec-butyle phenol) were selected for this experiment on maize. The concentration of these chemicals used both as Pre-emergence and Post-emergence sprayings are given below :—

TABLE I.

Serial No.	Chemicals.	Rate of application per acre. At Pre-emergence stage.	Rate of application per acre. At emergence stage.
1.	2, 4-D (2, 4-Dichloro-phenoxy acetic acid.)	4.0 lbs.	2.0 lbs.
2.	2, 4-Dichloro-phenoxy acetamide.	4.0 lbs.	2.0 lbs.
3.	Crag herbicide. 2, 4-Dichloro-phenoxy ethyl sulphate.	4.0 lbs.	2.0 lbs.
4.	T. C. B. Trichlorobenzoic acid.	1.5 lbs.	0.5 lbs.
5.	General weed killers (Dinitro-ortho-Sec-butyle phenol)	6.0 lbs.	4.0 lbs.

All the plots under these treatments were further divided into two sub equal plots. In the 1st half of each plot post emergence with 2, 4-D sodium salt at the rate of 1.25 lbs. acid equivalent per acre was given on 45th day after sowing, while in the second half of all the plots inter-cultivation was done on the same day. Besides these weedicidal treatments three more treatments were included which are as follows :—

(i) Hand weeding on 21st day after sowing. On 45th day this whole plot was again sub-divided into two, for the cultivation and post-emergence treatments as described above.

(ii) No weeding upto 45th day of sowing, thereafter the whole plot was subdivided into two, for cultivation and post-spraying.

(iii) Control :—No Weeding throughout.

Thus there were in all 25 treatments. The treatments and symbols used in the experiment are given in appendix table I.

The treatments were replicated three times in a randomized block design. The net plot size was 18′×12′. The crop was sown on Aug. 6, using 8 seers of seeds per acre. Plant to plant distance was 6″ in rows 1½′ apart.

RESULTS AND DISCUSSION

TABLE II.

Weed density per Square foot at successive stages of growth as effected by different treatments.

Treatments. symbols.	days after sowing. 15	30	50	60	Harvest.
a	7.66	14.33	14.00	11.33	11.66
A	8.66	15.00	19.33	29.00	32.00
b	5.44	16.33	15.33	32.33	33.66
B	3.66	18.33	12.66	10.66	11.33
c	18.66	13.66	20.00	20.66	20.66
C	18.66	25.00	12.33	5.00	6.00
d	37.00	42.66	28.66	21.00	22.00
D	34.33	46.66	17.66	7.66	10.00
e	25.33	32.00	26.66	21.00	22.33
E	25.66	25.66	9.66	12.33	14.00
al	32.00	11.33	8.00	13.66	14.66
Al	40.66	12.00	6.66	5.00	3.66
bl	27.66	5.33	11.33	7.00	8.66
Bl	30.00	5.66	4.66	3.66	3.66
cl	21.00	20.33	13.33	25.00	32.00
Cl	36.66	24.00	14.33	6.66	8.00
dl	32.60	18.66	17.66	25.66	31.00
Dl	31.00	28.66	8.66	5.66	7.33
el	33.00	36.33	25.66	12.33	12.66
El	25.66	25.66	13.00	23.33	23.66
f	34.30	36.33	26.00	33.00	34.00
F	39.00	33.00	19.00	6.66	7.66
g	41.66	41.00	26.00	25.00	25.00
G	32.33	24.33	6.00	5.00	6.00
H	48.66	48.33	33.00	35.66	55.00
C. D. at 5%	18.17	19.80	16.13	19.17	13.94
„ „ 1%	24.47	26.67	22.72	25.82	18.50

An examination of the weed density data represented in table II reveals that the emergence and Pre-emergence dressings when supplemented with cultivation at later stage, were better as compared to treatments supplemented with post emergence treatments. It would be seen that chemicals effectively controlled weeds in the emergence and pre-emergence plots. As compared to post sprayings, cultivation effects were well pronounced in checking the weed growth. Both forms of 2,4-D appear to be advantageous in controlling weeds. It may be argued here that better control of weeds obtained for the pre-emergence treatments of 2,4-D may be partly due to higher concentrations used and partly due to more susceptibility of young germinating weeds to this chemicals.

The study of the table will also indicate that with the pre-emergence and emergence treatments weeds were well controlled early in the season and later a considerable proportion of late germinating seedlings were checked by cultivation. The post spraying was not so effective. Therefore, a judicious combination of both chemical and mechanical weed control appears to give better results.

TABLE III.

Grain and Karbi yield as affected by different treatments.

Grain yield/acre in mds.		Grain yield per plant in gms.		Karbi yield per acre in mds	
Treatment.	Averages.	Treatment.	Averages.	Treatment.	Averages.
1	2	3	4	5	6
Al	18.08	Al	45.66	Bl	37.37
Bl	13.14	Bl	44.66	Al	32.77
B	13.00	B	43.66	Dl	25.62
G	12.50	G	43.66		
		C	43.60		
al	11.59	al	42.66	H	24.79
Dl	11.51	Dl	42.66	G	23.73
C	11.50	F	40.13	F	22.08
F	11.46	E	39.33	E	21.38
E	11.37	Cl	38.46	g	20.90
Cl	11.36	f	38.26	bl	20.32
f	10.67	g	37.66	f	19.32
g	10.20	c	37.60	cl	18.90
c	10.10	dl	37.40	Cl	18.35
e	9.73	e	36.30	C	18.24

TABLE III (Contd.)

Grain yield/acre in mds.		Grain yield per plant in gms.		Karbi yield per acre in mds.	
Treatment.	Averages.	Treatment.	Averages	Treatment.	Averages.
1	2	3	4	5	6
dl	9.34	bl	35.66	dl	17.96
bl	9.23	cl	35.13	al	17.64
cl	9.18	d	35.00	c	15.15
d	9.18	D	34.93	Dl	15.54
El	8.11	H	34.40	e	15.44
D	7.59			d	15.12
H	7.05			El	14.49
a	6.32	A	33.33	B	12.36
Cl	5.45	a	33.00	cl	12.19
A	5.06	b	32.80	a	10.81
b	4.51	El	32.00	A	9.67
		el	31.80	b	7.56
C. D. at 5%	5.67	—	11.20	—	12.52
C. D. at 1%	7.71	—	16.36	—	16.59

A critical study of table III will indicate that on the basis of statistical significant differences, there are three distinct groups for the 25 treatments. The grain yield in the first group varies from 18.08 to 12.53, the range of second group being 11.59 to 7.05 mds. while in the third group the variation in the yield is 6.32 to 4.51 mds. per acre. There is no statistical difference in between any two treatments within each group.

As expected the yield responses to the treatments were similar to those noted for the weed control observations. The produce of grain was recorded superior, in general, for the emergence treatments, and in particular, for the 2,4-D forms. It may be recalled that with emergence applications of 2,4-D weed control was good (Table II) and per plant grain yield was also improved. Such beneficial effect may be considered responsible for higher grain yields per plant under these treatments

When the yield data pertaining to emergence sprayings in conjunction with cultivations are examined, the advantages of cultivations in pre-emergence and emergence plots become quite clear. It was observed that the control of late germinating and resprouting weeds was better with cultivation as compared to the post emergence treatments. The highest yield obtained for the 2,4-D emergence treatment in conjun-

ction with cultivation may, therefore, be accounted for this better weed control efficiency and also for any advantage obtained, due to better aeration and tilth with cultivation.

Karbi yields under different treatments are classified statistically into three groups. The difference *between any two treatments within a group is non-significant.* In the first group the *Karbi* yield varies from 37.70 to 25.62 mds., while in the second group variation is from 24.79 to 14.49 mds./acre. In the third group yield varies from 12.36 to 7.56 mds. to the acre.

Amongst the treatment of the first group, treatment B1 (2,4-D acetamide plus inter cultivation) gives the best performance. It is interesting to note that in the second group all the treatments were inferior than the control, although the superiority of the control was non-significant. The concentration of 2,4-D sodium salt, 2,4-D acetamide, crag herbicide and trichlorobenzoic acid applied at emergency stage resulted in higher yields than the concentration of the same chemicals applied as pre-emergence spray. On the other hand the pre-emergence application of general weed killer proved to be better than its emergence spray. In general, cultivation singly or in combination with sprayings gave higher yields of *Karbi* than did chemical application alone.

Summary.

Both the forms of 2, 4-D were more effective in controlling weeds as compared to other chemicals. Pre-emergence applications were better than the emergence sprayings in killing weeds, possibly because of higher concentrations used at that stage. Weed control efficiency of general weed killer at both the stages was poor.

Cultivations proved better than the post-emergence treatments for controlling late germinating and resprouting weed.

APPENDIX TABLE I

Symbols for each treatment used in the experiment.

Treatment No.	*Treatments.*	*Symbols.*
1.	Pre-emergence with 2, 4-D Sod. Salt-Post Sprayings	a
2.	Pre-emergence with 2, 4-D Sod. Salt-Cultivations	A
3.	Pre-emergence with 2, 4-D acetamide-Post emergence	b
4.	Pre-emergence with 2, 4-D acetamide-cultivation	B
5.	Pre-emergence with Crag herbicide-Post emergence	c
6.	Pre-emergence with Crag-herbicide cultivation	C
7.	Pre-emergence with Trichlorobenzoic acid-Post emergence	d
8.	Pre-emergence with Trichlorobenzoic acid-Cultivation	D

Treatment No.	*Treatments.*	*Symbols.*
9.	Pre-emergence with general weed killer-Post emergence	e
10.	„ „ „ „ „ Cultivation	E
11.	Emergence with 2, 4-D Sod. Salt-Post emergence	al
12.	„ „ „ „ Cultivations	Al
13.	„ „ „ acetamide-Post emergence	bl
14.	„ „ „ „ Cultivation	Bl
15.	„ „ Crag herbicide-Post emergence	cl
16.	„ „ „ „ Cultivation	Cl
17.	Emergence with trichlorobenzoic acid-Post emergence	dl
18.	„ „ „ „ „ Cultivation	Dl
19.	Emergence with general weed killer Post emergence	el
20.	„ „ „ „ „ Cultivation	El
21.	Hand weeding-Post emergence	f
22.	Hand weeding-Cultivation	F
23.	No weeding upto 45th day-Post emergence	g
24.	No weeding upto 45th day—Cultivation	G
25.	Control (No weeding throughout)	H

COMPARATIVE PERFORMANCE OF DIFFERENT GREEN MANURE CROPS WITH AND WITHOUT PHOSPHATE ON SOIL FERTILITY AND YIELD OF WHEAT.

U. B. Singh.

Like most soils under tropical and sub-tropical climates Indian soils are poor in nitrogen and organic contents. For better farming in such soils, it is absolutely necessary to maintain the soil fertility through addition of organic matter. Green manuring is one of the ways to provide both organic matter and nitrogen to the fields. Phosphate application to green manure crops increases their efficiency for accumulation of nitrogen and organic matter.

Work at B. R. College, Bichpuri was carried out to compare this efficiency of different green manure crops for wheat in this area.

Experimental Procedure :

In the year 1955-56 a field experiment was conducted with 12 treatments comprising 6 green manure crops (Sanai, Cowpea, Moong Local, Moong Tl, Urad and Guar) and two phosphate doses (0, 40 lbs. P_2O_5) applied as single superphosphate at the sowing time and at turning the green manure crops after 7 weeks after sowing.

A randomised block design with 4 replications was adopted with net plot size as 15'x 36'. Green manure crops were sown on 25th July, 1955 followed by broadcast of superphosphate and stirred with bullock drawn Mc-cormic cultivator. Soil analysis was done at two stages at turning and at sowing of wheat for nitrogen and phosphorus.

Experimental Findings and Discussion :

A. Soil analysis—Samples from O"—9" depth were analysed for nitrogen and phosphorus at the time of turning of green manures and at the sowing time of wheat (i.e. 62 days after the burial of green manure crops). The differences at both the stages were very small and statistically non-significant.

At the turning time (growth after 7 weeks), with the exception of Guar, the soil status increased under all crops showing that all legumes except Guar added certain

quantity of nitrogen to the soil. The total addition of nitrogen due to turning of green manure crops ranged from 28 to 62 lbs. per acre, maximum in Sanai followed by Cowpea.

Phosphate applications always showed higher % of nitrogen at both the stages and appeared to be beneficial.

The addition of nitrogen per acre varied because of variations in amount of dry matter added by each crop. Sanai added significantly more dry matter per acre followed by Moong Local, Urad, Cowpea, Moong Tl and Guar (Table III). From the data in table III it is also clear that the crops of Sanai and Cowpeas have the power to fix more nitrogen than other legume crops included in this trial. The similar findings were those of Buffen (1900), Lohnis (1936) and Ripley (1941). They studied the effect of legumes on nitrogen content of soil and postulated that the nitrogen content of soils increases with the cultivation of legumes.

The phosphorus content of the soil decreased at turning under different green manure crops but at the sowing time of wheat due to decompostition of green manure crops an increase in P_2O_5 was visible, maximum (42.4 lbs.) by Sanai. Blair and Prince (1939) and Miller (1938) recorded an increase in phosphorus content of the soil under red and sweet clovers when grown in conjunction with superphosphate at New Jersey.

Lohnis (1926) enumerating the good effects of legumes pointed out that potash and phosphorus content of soil improves due to deep root system of legumes which help bringing these elements to surface.

B. Fresh and dry matter additions and Wheat yields:—The amount of green matter added at the time of turning was recorded and the moisture percentage in the plants were determined from which the dry matter added was calculated.

The data for fresh weight, dry weight additions and wheat yields were analysed statistically and significant effects for crops and phosphate were observed (Table No. III).

Sanai added the maximum dry matter per acre and it was significantly better than other crops in this respect. Second in order of merit was Moong Local which added significantly more dry matter than Urad, Cowpea and Moong Tl, which in turn were superior to Guar with non-significant differences among themselves. Maximum amount of green matter was added through Cowpea, Sanai, Moong Local and Urad, (The difference between them being non-significant) and minimum by Guar.

Phosphate applications in all crops had produced more green and dry matter over controls. Sanai in presence of phosphate had the greatest addition of dry matter over others.

TABLE I

Average Nitrogen Content of Soil at turning and before sowing wheat.

S. No.	Crop	Initial N Contents N%	lbs. per acre	N% at turning PO	Pl	Mean	Amount lbs. per acre	N Added per acre	N% at sowing Wheat PO	Pl	Mean%	Amount lbs. per acre	Total addition in lbs. per acre
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Sanai	.0409	818	.0418	.0421	.0419	828	+10	.0435	.0444	.0440	880	62
2.	Cowpea	"	"	.0413	.0419	.0416	832	+14	.0432	.0434	.0433	866	48
3.	Urad	"	"	.0414	.0418	.0416	832	+14	.0427	.0434	.04305	861	43
4.	Moong Local	"	"	.0411	.0414	.0413	826	+ 8	.0427	.0432	.0429	858	40
5.	Moong Tl	"	"	.0410	.0418	.0414	828	+10	.0425	.0432	.0428	856	38
6.	Guar.	"	"	.0319	.0402	.04007	801.4	−16.6	.0417	.0419	.0418	836	18
						Pl-PO					Pl-PO		
	Mean for Phosphate.			.0411	.0415	.0004			.0427	.0432	.005		
	Lbs. per acre.			822		830	8		854		864	10	
	S. E.			—	±.0016 (Crops)				—	±.0003 (Crops)			
				—					—				
				—	±.0003 (Phosphate)				—	±.0001 (Phosphate)			
				—					—				

The favourable effect of phosphate on green and dry matter production may be attributed to its direct effect in increasing fixation of atmospheric nitrogen, resulting in greater vegetative activity. Such effects have been reported by Lohnis (1902), Feller (1918) and Howell (1952) working on Soyabeans, Donald Rost and Karmer (1952) on legumes independently observed increased fresh weight and dry matter by application of phosphorus.

Wheat yields (Grain and Bhusa) were significantly superior in plots Green manured with Sanai and Cowpea followed by Moong TI, Moong Local, Urad and Guar in order of merit. The variation in grain and bhusa yields were closely related to the amount of nitrogen added per acre by respective green manure crops (Table I.).

Lohnis (1936), Vyas and Desai (1953) working on green manures and their residual effect on succeeding wheat found increases of 37.2 to 100% in grain yield by green manures.

Wheat yields in phosphate treated plots were superior over controls which may be attributed to the effect of phosphorus in increasing the nitrogen fixation by legumes. The greater availability of phosphorus to wheat crop under these treatments could have increased the efficiency of plants to grow and yield more. Sethi (1935), and Parr and Bose (1945) found significant increases with green manuring in conjunction with 60 lbs. P_2O_5 per acre of paddy and wheat crops.

Green manuring with Moong at Indore (1954-55) with 30 lbs. P_2O_5 showed significant increases in yield of wheat.

Summary:—Green manuring with either Sanai or Cowpea was equally good for wheat yields but as regards the improvement in soil fertility Sanai proved superior over cowpea and phosphate application @ 40lbs. P_2O_5 per acre appeared benificial.

TABLE II

Changes in Phosphorus Content of Soil from Sowing of Green Manures to Sowing of Wheat.

S. No.	Crops.	Initial Phosphate P_2O_5 ; lbs. per acre		P_2O_5% at turning PO	Pl	Mean%	Amount lbs. per acre	Amount added	P_2O_5% at sowing Wheat PO	Pl	Mean%	Amount lbs. per acre	Total addition
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Sanai	.08343	1668.6	.08242	.08469	.08355	1671.0	2.4	.08458	.08652	.0855	1711.0	42.4
2.	Cowpea	"	"	.08287	.08296	.08240	1662.2	−16.4	.08442	.08575	.0849	1689.4	20.8
3.	Urad	"	"	.08222	.08288	.08255	1651.0	−17.6	.08381	.08497	.08439	1687.8	19.2
4.	Moong Local	"	"	.08229	.08265	.08247	1649.4	−19.2	.08443	.08481	.08462	1692.4	23.8
5.	Moong Tl	"	"	.08227	.08250	.08238	1647.6	−21.0	.08420	.08458	.08439	1687.8	19.2
6.	Guar	"	"	.08312	.08366	.08339	1667.8	− 0.8	.08343	.08381	.08362	1677.4	3.8
						Pl-PO						Pl-PO	
	Mean for Phosphate	"		.08243	.08322	.00079			.08414	.08507		.00093	
	Amount of P_2O_5 lbs. per acre.			1648.6	1664.4	15.8			1682.8	1701.4		18.3	
S. E.				.0092 (Crops)		.0052 (Phosphate)			.0058 (Crops)		.0036 (Phosphate)		

TABLE III

Average Fresh and Dry Matter Addition per acre Through Green Manure Crops and Respective Wheat Yield.

Crops	Green matter addition in lbs per acre			Dry matter addition in lbs. per acre			Grain yield in lbs. per acre			Bhusa yield in lbs. per acre		
	P	Pl	Average	PO	Pl	Average	PO	Pl	Average	PO	Pl	Average
Sanai	14128.20	17004.60	15566.40	2761.68	3400.92	3075.80	1696.11	1892.21	1794.16	3506.96	3712.32	3609.64
Cowpea	15508.14	17002.26	16255.20	1778.06	1889.14	1833.60	1636.72	1990.96	1813.84	3275.67	3681.21	3478.44
Urad	14059.66	16589.34	15324.00	1974.96	2225.62	2076.84	1411.74	1530.42	1471.08	2973.96	3198.28	3086.21
Moong Tl.	9150.58	11421.62	10285.60	1495.34	1631.66	1563.00	1474.08	1631.12	1557.60	2803·92	3118.96	2986.44
,, Local	15457.74	17433.40	16445.60	2230.73	2599.27	2415.00	1485.78	1756.63	1618.68	2837.26	3384.02	3160.64
Guar	6164.88	7705.52	6935.20	1056.82	1338.19	1197.50	1356.01	1480.31	1413.68	2764.75	2814.53	2789.64
S. E.			±661.84			±108.80			±38.81			±119.92
C. D.			1936.20			297.60			115.78			359.81
Average for phosphates	12403.20		14526.10	1899.60	2180.80		1510.07	1713.60		3027.08	3336.88	
S. E.	±388.0			±65.68			±22.38			±69.72		
C.D.	1115.20			171.20			66.58			208.77		

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EFFECT OF TYPE OF BUD AND DATE OF LOPPING ON THE BUDDING OF MOSAMBI (*Citrus SINENSIS* OSBECK) AND GRAPEFRUIT (*C. PARADISI* MACF.)

Ajit Singh, R. G. Maiti and S. M. Singh.

The importance of vegetative propagation in citrus has been realised since long; and most of the commercial species are multiplied by cutting, layering, budding, grafting or by apogamic seedlings. For mosambi and grapefruit budding is by far the most important way of vegetative propagation. Different procedures for budding are followed by the growers and nurserymen. Generally the wood chip attached at the ventral surface of the bud-shield is removed before inserting it into the matrix. One group of scientists (Mendel, 1936, Kartar Singh and Sham Singh, 1947 and Stevenson, 1947) holds that percentage of success in budding is improved by this method, while another group (Naik, 1939, and Hume, 1947) prefers the retention of the wood chip.

The time of heading back of the rootstock is also disputed by many workers. Basant Singh (1945) and Kartar Singh and Sham Singh (1947) recommended in favour of removing the tops just after budding to get the marketable plants of larger size in the same season, but Cheema and Dubhasi (1938), Naik (1939) and Hume (1949) advised to delay the operation by about one month after budding.

The above conflicting views regarding the types of scion bud and the time of budding, therefore, warranted the necessity of the present investigation, which was carried out during the year 1956 at the B. R. College Research Station, Bichpuri, Agra, with a view to ascertain the right type of bud and the correct time of lopping in order to achieve the highest percentage of success in budding of mosambi and grapefruit.

Experimental procedure.

In this experiment Kharna Khatta (*Citrus karna* Raf.) was used as rootstock. Budding was done on 15th Feb. 1956 when the shield shaped scion buds were inserted in the T-matrix. The factors tried in this experiment were :—

(1) Species of citrus— (a) mosambi (*Citrus Sinensis* Osbeck)
(b) grapefruit (*C. paradisi* Macf.)

(2) Types of scion bud—(a) buds with wood
(b) buds without wood

(3) Time of lopping— (a) just after budding.
(b) one month after budding.

Thus there were eight treatment combinations, each with ten plants, which constituted a plot. The design was randomised block replicated four times. Regular observation regarding (a) but-take (b) success (c) time taken for bud-break were taken at fortnightly intervals upto eight weeks after budding operation. Length of the budling was measured in the final observation.

Experimental findings.

Buds that remained green (either dormant or growing) upto the time of final reading were considered to have taken and those that were growing were recorded as successful. The percentage of such buds to the total number of plants budded in each plot was calculated to find out the 'per cent bud-take' and 'per cent success' respectively.

The performance of the two scion species was clearly marked regarding the various characters studied. It was found that the 'per cent bud-take' as well as 'per cent success' were much higher in mosambi in comparison to grapefruit, the differences being significant at 5 per cent level (Table I). Though there was not much difference in the time taken for bud-break between the two species, the budlings produced by the former were much longer. Moreover, in anatomical studies it was revealed that the production of callus tissues for bud union was earlier and quite profuse in case of mosambi than in grapefruit.

TABLE I

Performance of the two scion species.

Scion species	Per cent bud-take	Per cent success	Length of budling (c. m.)
Mosambi	48.75	47.65	12.64
Grapefruit	38.12	30.47	10.94
C. D. at 5%	8.86	16.22	—
C. D. at 1%	—	—	1.98

'Per cent bud-take' was improved to almost two and a half times by using buds without wood in comparison to buds with wood (Table II). The former method

also increased the 'success' by more than 125 per cent over the latter. Removal of wood-chip from the ventral surface of the bud-shield also resulted in the production of longer budlings, though, lesser time was taken for bud-break by its retention.

TABLE II

Effect of type of scion bud.

Treatment	Per cent bud-take	Per cent success	Time taken for bud-break (days)	Length of budling (c. m.)
Buds with wood	25.00	23.70	27.83	9.57
Buds without wood	61.87	54.39	30.14	14.01
C. D. at 1%	12.00	24.09	1.05	1.98

Time of lopping also affected the different characters significantly. 'Per cent bud-take' was more than doubled by lopping the tops of the rootstock one month after than when this operation was done immediately after budding (Table III). 'Per cent success' was 54.39 in the former case, while it came down to 23.70 when the latter method of lopping was tried. The time taken for bud-break, on the other hand, was considerably reduced by lopping just after budding and the budlings also were much longer.

TABLE III

Effect of time of lopping

Treatment	Per cent bud-break	Per cent success	Time taken for bud-break (days)	Length of budling (c. m.)
Lopping just after budding	27.50	23.70	23.09	13.60
Lopping one month after budding	59.38	54.39	34.90	9.33
C. D. at 1 %	12.00	24.09	1.05	1.98

Discussion.

The results of this experiment have shown that the vegetative propagation of mosambi by budding gave better success in comparison to grapefruit. This difference is due to the delay in the formation of callus for the bud union in the latter as was revealed by the anatomical studies. This also explains the better growth of budlings produced by mosambi buds.

The removal of wood-chip from the ventral surface of the scion buds resulted in higher percentage of success and longer budlings, though it caused some delay in bud-break. This difference in performance was mainly due to better mechanical contact of cambial layers over a larger surface by the removal of wood-chip which otherwise acted as an agent of separation between the scion and the rootstock at the matrix. An early 'break' of buds with wood was probably due to more scion-food reserved in the wood chips. Similar results were obtained by Kartar Singh and Sham Singh (1947) also.

Higher percentage of success was obtained in this experiment by lopping the tops one month after budding ; though the time taken for bud-break was more and the budlings produced under this treatment were shorter in comparison to the lopping of rootstocks immediately after budding. The adverse effect of immediate lopping on the success of budding seems to be because of a sudden shock to the plant which tells upon the physiological activities adversely. This finding is in close confirmity with the earlier findings of Bhadauria *et al* (1959) made at this research station. Where the union was effected, the budlings got the advantage of earlier nourishment from the rootstocks and, therefore, produced an earlier break and better growth. Similar results were obtained by Basant Singh (1945) also.

Summary.

A series of experiments were carried out at the B. R. College Research Station, Bichpuri, Agra, on the propagation of citrus by budding. One of these experiments is described in the present paper.

In this experiment mosambi (*Citrus sinensis* Osbeck) and grapefruit (*C. paradisi* Macf.) scions were budded on Karna khatta (*Citrus karna* Raf.) rootstocks by T-method. Buds with wood and without wood were tried along with two types of lopping.

Higher percentage of success was obtained with mosambi scion-buds than with grapefruit and the removal of the wood-chip from the ventral surface of the bud was found to increase the success by more than 125 per cent. It was also found that more buds were united when lopping was done one month after budding in comparison to that done immediately after budding though, in the latter case an earlier bud-break as well as longer scion shoots were obtained.

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RESPONSE OF FOUR VARIETIES OF POTATO TO DIFFERENT PLANTING DATES.

R. R. Rao, S. M. Singh, S. P. S. Rathore and I. J. Singh.

Potato is among the most important as well as largely cultivated vegetable crops of India giving the highest yield of edible product and food energy per acre. In comparison to other countries like Belgium, Ireland, Scotland, England and Germany, the average yield per acre in India is still far behind. Two of the most important causes for the low yield are (a) failure to select a variety suitable for the tract and (b) failure to sow the crop at optimum time to provide the required environmental conditions for proper performance. The existing recommendations are too general covering a very wide region. Chandrani (1951) recommended Phulwa, Darjeeling Red Round and some hybrids for Northern India with planting time before 15th October. For Patna region Ramanujam (1951) advised October for Satha and Phulwa varieties and November for Darjeeling Red Round as the best time for planting. Mitra (1951) recommended last week of October and first week of November as the optimum period of planting for the plains of U. P. It is, therefore, necessary to find out suitable varieties and their optimum time of planting for various potato growing regions for getting high yields.

The present paper deals with the results of an experiment carried out at B. R. College Experimental Station, Bichpuri, Agra during the winter season of 1954-55 to study the effect of four planting dates on growth, yield and quality of four varieties of potato.

Materials and Methods.

Four varieties of potato viz., Patna Phulwa, Darjeeling Red Round, Patna Red and Uptodate were planted at four different dates i. e. October 9, October 23, November 6 and November 20, 1954. The size of seed tubers varied from 0.75 to 1.25 inches in diameter. Before planting the tubers were kept at room temperature for 15 days after removal from cold store and only sprouted tubers were planted in order to ensure germination. The size of each net plot was $18' \times 15'$. Row to row distance was 18" and plant to plant 9". The design of layout was randomised block with four replications.

Experimental Findings.

Yield and grades of tubers.

The yield and grades of potato tubers were greatly influenced by varieties and planting dates (Table I). Of the four varieties tried Patna Phulwa yielded the highest per acre and Uptodate the lowest. Darjeeling Red Round and Patna Red proved to be medium yielders.

TABLE I

Yield and percentage of different grades of potato tubers as influenced by variety and planting date.

Treatments	Yield per acre (in mds.)	Percentage of grades of tubers		
		A (diam. more than 1.25")	B (diam. 0.75" to 1.25")	C (diam. below 0.75")
Varieties :				
Patna Phulwa	256	37.6	42.2	20.2
Darjeeling Red Round	237	49.8	37.9	12.3
Patna Red	217	47.7	39.6	12.7
Uptodate	168	74.8	20.9	4.3
Planting dates :				
October 9	182	53.5	37.4	9.1
October 23	281	57.6	35.8	6.6
November 6	247	51.9	33.2	14.9
November 20	168	33.3	40.9	25.8
C. D. at 5 %			20.4	
C. D. at 1 %			26.3	

The influence of varieties on grade composition of yield was very much striking. Uptodate produced the highest percentage of A grade tubers and Patna Phulwa the lowest. This position was reversed with respect to B and C grade tubers which were found to be highest in Patna Phulwa and lowest in Uptodate. Darjeeling

Red Round and Patna Red did not vary much with respect to different grades of tubers and were again in between the other two varieties.

The highest yield of tubers was obtained by planting potato on October 23. Shifting the planting date earlier or later resulted in a reduction of yield of tubers. October 23 also proved to be most suitable with regard to production of highest percentage of A grade tubers and lowest of C grade tubers. The percentage of A grade tubers decreased and C grade increased when plantings were done earlier or later than this. The percentage of B grade tubers did not vary much on different dates of planting.

The interaction between varieties and planting dates (Table II) showed that the highest yield of Potato tubers in all the varieties was obtained by planting them on October 23. Planting earlier than this reduced the yield significantly, the reduction being more marked in Uptodate, Patna Red and Darjeeling Red Round than in Patna Phulwa. Later plantings also reduced the yield but to a less extent than the earliest one. The difference between the yields of Patna Phulwa and Uptodate which were the highest and lowest yielding varieties was most marked on first planting. With delay in planting the differences narrowed down till on the last planting of November 20 it was not even significant. The overall superiority of Patna Phulwa was infact mainly due to comparatively much better performance in the early plantings. When the planting was done in the month of November, the yield of this variety was even slightly less than that of Darjeeling Red Round.

TABLE II

Effect of interaction between varieties and planting dates on the yield of potato tubers per acre (in mds.)

Varieties	Planting dates			
	Oct. 9	Oct. 23	Nov. 6	Nov. 20
Patna Phulwa	270	312	262	182
Darjeeling Red Round	194	283	281	188
Patna Red	176	286	246	159
Uptodate	87	244	198	145
C. D. at 5%		41.1		
C. D. at 1%		53.1		

Growth and tuberization.

The varieties of potato tried in this experiment showed marked differences in their growth and tuberization habits. Though Patna Phulwa produced significantly smaller number of s hoots per mother tuber than Darjeeling Red Round the fresh weight of shoots per plant in the two varieties did not differ much and it was much higher than that of the other two varieties (Table III). Patna Phulwa produced the highest numbers of tubers per plant but unfortunately the average weight of the tubers was the lowest in this variety. Uptodate produced the poorest vegetative growth, and though the average weight of its tubers was about seven times of that of Patna Phulwa, the number of tubers was less than one eighth, with the result that the weight of tubers per plant was much less in comparison to Patna Phulwa. Patna Red was also much better than Uptodate in all characters except the size of individual tubers but it was on the whole much inferior to the other two varieties.

TABLE III

Growth and tuberisation of potato as influenced by varieties and planting dates.

Treatments	Number of shoots per mother tuber	Fresh wt. of shoots per plant (gm.)	Number of tubers per plant	Wt. of tubers per plant (gm.)	Average wt. of tubers per plant
Varieties :					
Patna Phulwa	2.80	118	35.6	255	7.2
Darjeeling Red Round	3.40	124	22.3	240	10.8
Patna Red	2.70	85	24.6	234	9.5
Uptodate	1.20	66	4.3	203	47.2
Planting dates :					
Oct. 9	2.56	91	16.3	195	11.9
Oct. 23	2.93	124	22.8	310	13.6
Nov. 6	2.25	95	26.2	267	9.9
Nov. 20	2.50	93	21.6	166	7.7
C. D. at 5 %	0.49	24.4	2.60	18.6	—
C. D. at 1 %	0.64	31.5	3.25	24.0	—

Growth and tuberisation were also much affected by the dates of planting. Planting on October 23 proved to be most suitable almost in all respects and earlier as well as later plantings resulted in less vegetative growth, smaller tubers and less yield per plant.

Discussion.

The findings of this experiment have shown that Patna Phulwa produced the highest yield of tubers per acre and Uptodate the lowest. Darjeeling Red Round and Patna Red were inferior to Patna Phulwa but they were far better than Uptodate. Patna Phulwa produced the largest number and weight of tubers per plant and since the plant population in all the varieties was the same, the marked difference in number of tubers per plant was well expressed in the final yield of tubers per acre, though the size of individual tubers in Patna Phulwa was the smallest. The number of tubers per plant in Uptodate was very small in comparison to other varieties and, therefore, the bigger size of tubers in this variety could not compensate for much smaller number of tubers per plant. Mitra (1951) reported that Patna Phulwa was a very high yielding variety. Pal and Pushkarnath (1950) suggested that Darjeeling Red Round and Patna Red were the same variety with two different names denoting the place of supply.

The final yield as well as growth and tuberisation were markedly affected by the date of planting. When planting was delayed by a fortnight after October 9, the yield increased by about 50%. Further delay in planting was associated with a reduction in yield. The grade composition of yield was also the best when planting was done just after the third week of October. It was the poorest when planting was done as late as November 20. These differences were mainly caused by variations in temperature at different stages of growth of plants including the period available for completing their life. High temperature in the earliest planting increased respiration in aerial parts and thus reduced the amount of available carbohydrates. Bushnell (1925) also observed that higher temperature would reduce the final yield of potato tubers. In late plantings the period available for growth was very much reduced because high temperatures set in before the plants had completed their full growth and development of tubers. Hill (1941) found that late plantings nullified the advantage of even certified seed.

The differences in the yield of varieties were the highest on first planting and they gradually narrowed down till the last planting. It appears that varieties differed markedly in their response to variations in temperature, Uptodate suffering the maximum by higher temperature of the earliest planting.

Summary :

Patna Phulwa was found to be the highest yielding variety and Uptodate the poorest. Darjeeling Red Round was only slightly inferior to Patna Phulwa

whereas Patna Red was markedly inferior but even this was much better than Uptodate. In respect of size of tubers, on the other hand, Uptodate was the best since about 75% of its tubers were of A grade and less than 5% in C grade. In Patna Phulwa the percentage of A grade tubers was about half of that of Uptodate but B and C grade tubers were many times more.

Planting soon after the third week of October (October 23) was found to be the best time for growth, tuberisation as well as yield of tubers in all varieties. Earlier as well as later plantings caused a marked reduction in growth and development of plants as well as yield of tubers.

The difference in the yield of different varieties was most marked in the earliest planting and it narrowed down with delay in planting.

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EFFECT OF HEAT PROCESSING ON THE CAROTENE AND VITAMIN A CONTENT OF MILK.

J. P. Agrawal and S. N. Singh.

Osborne and Mendel (1913) and McCollum and Davies (1915) demonstrated that vitamin A is comparatively stable to heat. The contradictory views were put forth by Steenbock, Boutwell and Kent (1918) and Drummond (1919). Zilva (1920 a) confirmed that vitamin A value of butterfat is lost by exposure to ultra-violet light. On the other hand, Wijngaarden (1934), Gillam et al., (1937) Holmberg (1937), Deco (1939), Vinet et al., (1941), Anguloe et al., (1948) observed that vitamin A content of milk is not affected by pasteurisation. Similarly Krauss, Erb and Washburn (1933) failed to establish any difference in the rate of growth and the incidence of ophthalmia or respiratory disease in rats receiving raw or pasteurised milk. Contrary to these findings Rogick and Rogick (1946) reported a loss of 20 percent during pasteurisation. Conflicting views exist in the literature regarding the loss of vitamin A as a result of other heat treatments such as boiling for different durations (Decaro and Speier 1935 ; De and Majumdar, 1938 ; Gillam et al., 1938; Kon, 1938 ; Deco, 1939 ; Henry et al., 1939 ; Escudero et al., 1944 ; Henry et al., 1939 ; Escudero et al., 1944 ; Henry et al., 1944 ; Sharp and Coworkers, 1945 ; Angulo et al., 1948 ; Gologorskii, 1948 ; Bose and Subramanyam, 1950 and Wagner, 1952 a).

It appears from the literature cited above that inspite of manifold attempts the investigations in the past have failed to establish a relationship between the heat processing of milk and its vitamin A potency. They have, however, agreed to a reasonable extent on one point that pasteurisation does not act adversely. But in India pasteurisation is carried out only in a few well organised dairies and the quantity of milk handled is very little as compared to that put in the market for fluid consumption. Boiling and simmering are the commonest heat treatments given to milk before consumption. Consequently, the problem remains still open so far as the conditions in India are concerned, and it is with this aim in view that the present investigation was instituted. The plan of the work was as under :—

A. *Effect of Pasteurisation.*
- (i) Raw (Control).
- (ii) Pasteurised at 161° F for 16 seconds.
- (iii) Pasteurised at 170° F for 16 seconds.
- (iv) Pasteurised at 145° F for 30 minutes.

B. *Effect of Simmering.*
- (i) Raw (Control).
- (ii) Just boiled and simmered for 5 minutes.
- (iii) Just boiled and simmered for 10 minutes.

C. *Effect of Boiling.*
- (i) Raw (Control).
- (ii) Boiled for 7 minutes.
- (iii) Boiled for 15 minutes.

Experimental Technique.

Samples of fresh milk of individual cows and buffaloes were obtained from the college dairy and were treated according to the plan.

The technqiue, recommended by Boyer, Spitzer, Jensen and Phillips (1944) for carotene and vitamin A estimations was employed and the estimations were done with the help of Lovibond Tintometer. Ferguson (1935) curve was employed for the conversion of Lovibond Yellow Units into carotene and the factor recommended by Mc Dowell (1949) for vitamin A content.

$$\frac{\text{Moor's Blue Units per 100 c.c. milk}}{5} = \mu\text{g. vitamin A per 100 c. c. milk.}$$

To represent the data in a more common and convenient form for comparision, carotene, vitamin A and the total vitamin potency have finally been expressed in terms of I. U. which were obtained after Barnicoat (1947) as under :—

Carotene :— I. U. per 100 c.c.=mg. per 100 c.c. x 1.67

Vitamin A :—I. U. per 100 c.c.=mg. per 100c. c. x 3.2

Experimental Findings.

The study under the present investigations has been confined to the effect of different heat treatments on the carotene, vitamin A and the total vitamin A potency of cow and buffalo milk. The results are presented and discussed in the following pages.

Effect of Heat Processing on carotene contents :—It can be seen from Table I that with normal milk, all the types of processing, *viz.*, pasteurisation, simmering and boiling, caused significant losses of carotene in cow milk. The smallest loss of 6.74 percent was observed in pasteurisation at 161°F for 16 seconds. Raising the temperature in this case to 170°F proved no more destructive. However, pasteurisation at 145°F for 30 minutes caused a loss of 11.2 percent.

TABLE I

Effect of Heat Processing on the Carotene Content in Cow Milk

	Carotene I. U. per 100 ml.									
		Pasteurisation				Simmering			Boiling	
Sample No.	Raw	161°F for 16 sec.	170°F for 16 sec.	145°F for 30 mts.	Raw	for 5 mts.	for 5 mts.	Raw	for 7 mts.	for 15 mts.
1.	17.0	16.0	16.0	15.0	14.0	12.2	12.2	15.0	12.72	11.30
2.	16.0	15.0	15.0	14.0	17.0	15.6	15.0	18.0	15.56	11.00
3.	16.0	14.7	14.7	14.2	18.7	16.9	16.0	33.3	28.38	25.40
Av.	16.33	15.23	15.23	14.4	16.57	14.9	14.5	22.1	18.89	16.90
% Loss	—	6.74	6.74	11.2	—	10.08	12.49	—	14.52	23.53

When the milk was just boiled and allowed to simmer for 5 minutes the loss of carotene was recorded to be 10.08 percent. Further increase in simmering period to 10 minutes raised the loss to 12.49.

Boiling caused the heaviest losses during the course of this experiment. Milk lost the carotene content to the extent of 14.52 percent when boiled for 7 minutes and 23.53 percent when boiling was continued for 15 minutes.

Effect of Heat Processing on Vitamin A in Cow Milk :—Results contained in Table II reveal that like carotene, vitamin A content of milk is also affected during the processing of milk. The losses are, however, small as compared to carotene. The lowest loss of 4.46 percent was observed in pasteurisation at 161°F for 16 seconds. Raising the temperature to 170°F resulted in 6.28 percent destruction. However, pasteurisation at 145°F for 30 minutes gave a loss of 9.36 percent.

Milk lost its vitamin A content to the extent of 7.88 percent when it was simmered for 5 minutes only. Increase in simmering period to 10 minutes raised the loss to 10·03 percent.

Boiling caused the maximum loss in vitamin A content too. A loss of 13.90 percent was observed when the milk was boiled for 7 minutes and of 16.73 percent when boiling was continued for 15 minutes.

Effect of Heat Processing on the Total Vitamin A Potency of Cow Milk :—Like carotene and vitamin A, the total vitamin A potency of cow milk also suffered losses of sufficient magnitude on account of the heat treatments. Pasteurisation at 161°F for 16 seconds was again the treatment showing the smallest loss of 4.94 percent. Raising the temperature to 170°F increased the loss to 6.6 percent. The loss in the holding method of pasteurization amounted to 9.89 percent.

A loss of 8.31 percent was recorded when the milk was just boiled and allowed to simmer for 5 minutes. Increasing the simmering period to 10 minutes raised the loss to 11.92 percent.

Boiling again caused the highest loss. Milk lost its vitamin A potency to the extent of 14.06 and 18.48 percent when boiling was done for 7 and 15 minutes respectively.

Effect of Heat Processing on the Vitamin A Content in Buffalo Milk:—A perusal of Table IV reveals that there is no carotene in buffalo milk, a finding which is supported by Davies (1939) and Shroff et al., (1954). All the three types of processing, *viz.*, pasteurisation, simmering and boiling caused some loss of vitamin A. A negligible loss of 1.6 percent was observed in pasteurisation at 161°F for 16 seconds. Higher temperature of 170°F proved no more destructive. However, pasteurisation at 145° F for 30 minutes caused a loss of 6.44 percent.

TABLE II

Effect of Heat Processing in the Vitamin A in Cow Milk.

	Vitamin A I. U. per 100 ml.									
		Pasteurisation				Simmering			Boiling	
Sample No.	Raw	161°F for 16 sec.	170°F for 16 sec	145°F for 30 mts.	Raw	for 5 mts.	for 10 mts.	Raw	for 7 mts.	for 15 mts.
1.	78.00	75.00	72.00	69.60	72.00	65.60	65.60	59.00	50.80	46.70
2.	68.50	65.60	65.60	63.40	72.00	68.80	65.80	74.60	63.60	62.40
3.	49.30	46.40	46.40	44.40	55.40	49.30	46.00	57.00	49.70	48.60
Av.	65.27	62.33	61.33	59.13	66.47	61.23	59.80	63.53	54.70	52.70
% Loss	—	4.46	6.28	9.36	—	7.88	10.03	—	13.90	16.73

TABLE III

Effect of Heat Processing on the total Vitamin A Potency of Cow Milk.

	Total Vitamin A potency I. U. per 100 ml.									
		Pasteurisation				Simmering			Boiling	
Sample No.	Raw	161° F for 16 sec.	170 °F for 16 sec.	145° for 30 mts.	Raw	for 5 mts.	for 10 mts.	Raw	for 7 mts.	for 15 mts.
1.	95.00	91.00	88.00	84.60	86.00	77.80	77.80	74.00	63.52	58.00
2.	84.50	80.60	80.60	77.40	89.00	84.40	80.80	92.60	79.16	76.40
3.	65.30	61.60	61.10	58.60	74.10	66.20	62.00	90.30	78.08	74.00
Av.	81.60	77.56	76.23	73.53	83.04	76.13	73.13	85.63	73.59	69.80
% loss	—	4.94	6.60	9.89	—	8.31	11.92	—	14.06	18.48

TABLE IV

Effect of Heat Processing on the Vitamin A content in Buffalo Milk.

Sample No.	Vitamin A. I. U. per 100 ml.									
		Pasteurisation			Simmering			Boiling		
	Raw	161 °F for 16 sec.	170 °F for 16 sec.	145 °F for 30 mts.	Raw	for 5 mts.	for 10 mts.	Raw	for 7 mts.	for 15 mts.
1.	65.20	64.00	64.00	60.80	86.40	80.00	78.40	89.60	80.00	76.80
2.	58.80	57.60	57.60	54.40	64.02	58.93	57.68	83.20	73.60	70.40
3.	74.40	73.60	73.60	70.40	64.02	59.24	57.97	73.60	64.00	61·80
Av.	66.13	65.07	65.07	61.87	71.48	66.06	64.68	82.13	72.53	69.67
% loss	—	1.6	1.6	6.44	—	7.57	9.50	—	11.69	15.17

Simmering for 5 minutes resulted in a loss of vitamin A content of the buffalo milk to an extent of 7.57 percent. Further increase in simmering period to 10 minutes raised the loss to 9.50 percent.

In this case too, boiling caused the maximum loss. Boiling for 7 minutes resulted in a loss of 11.69 percent which increased to 15.17 percent when boiling was continued for 15 minutes.

Discussion.

For convenience of study and discussion the losses suffered by milk carotene and vitamin A on account of various heat treatments are summarised in Table V. When the effect of pasteurisation is considered in general it is evident that pasteurisation brings about a loss from 6.74 to 9.79 percent in carotene and 4.46 to 9.36 in vitamin A of cow milk. Likewise for buffalo milk the losses are from 1.6 to 6.44 percent. These findings agree with Rogick and Rogick (1946) in supporting the view that both carotene and vitamin A are not heat resistent during pasteurisation, although the extent of loss differs markedly in the two cases, it being 20 percent of vitamin A in the case of above workers. In fact we are close to Krauss Erb and Washburn (1933) who found that carotene and vitamin A are fairly heat resistent during pasteurisation. Our results do not support the findings of Wijngaarden (1934), Gillam et al., (1937) and Sommer (1945) who observed that vitamin A in milk is not affected by pasteurisation. Similarly they do not corroborate the observations of Shroff et al., (1954) which suggest that pasteurisation causes no significant loss of carotene. Higher losses in holding type of pasteurisation are suggestive of the fact that it is the time of exposure of the sample to the conditions favourable for oxidation which is more important than any other factor in pasteurisation.

TABLE V.

Percentage Loss (due to the effect of heat) in carotene, Vitamin A and total potency in cow and buffalo milk.

Serial No.	Treatments	Cow Milk			Buffalo Milk
		Carotene	Vitamin A	Total Potency	Total Potency
1.	Pasteurisation at 161°F for 16 seconds.	6.74	4.46	4.94	1.60
2.	Pasteurisation at 170°F for 16 seconds.	6.74	6.28	6.60	1.60
3.	Pasteurisation at 145°F for 30 minutes.	9.79	9.36	9.89	6.44
4.	Simmering for 5 minutes.	10.08	7.88	8.31	7.57
5.	Simmering for 10 minutes.	12.49	10.03	11.92	9.50
6.	Boiling for 7 minutes.	14.52	13.90	14.06	11.69
7.	Boiling for 15 minutes.	23.53	16.73	18.48	15.17

Severeness of simmering over any type of pasteurisation as illustrated by figures contained in Table V is the result of judicious contribution of both time and temperature. The results of boiling are still more interesting and fall in agreement with quite a few previous workers. Decaro and Speier (1935) observed a loss of vitamin A as a result of boiling. De and Majumdar (1938) observed a loss of 36.7 percent of vitamin A in milk due to prolonged heating. Deco (1939) found that prolonged boiling was destructive to vitamin A. Rogick and Rogick (1946) noticed about 40 percent loss of vitamin A in domestic boiling. On the other hand, Hass and Meulemans (1938) observed that even boiling produces no loss of carotene and vitamin A.

In general the carotene content showed higher destruction than vitamin A in milk. This may be ascribed to the greater sensitiveness of carotene to oxidation and to the action of heat. Of the heat treatments given during the course of this investigation boiling proved to be most serious. Probably this is due to the high temperature and more surface area exposed to air during boiling for any given length of time.

Summary.

Heating the milk before cousumption is universally practised in India. The method and extent of heating, no doubt, vary from place to place. Pasteurisation of milk is carried out in a few well organised dairies and the quantity of milk handled is very small as compared with the total milk offered for fluid consumption. The most common practice is to bring the milk to the first boil and then to keep it simmering over extended periods.

Milk contains a number of constituents which are sensitive to heat and would, therefore, be affected by its being subjected to heat under the various processes. The information available on the subject is scanty and need necessarily be gathered before any authentic recommendation can be made. With this aim in view the present investigation was instituted to study the influence of heat processing on its carotene and Vitamin A values.

For the determination of carotene and vitamin A the method devised by Boyer et al., (1944) was employed.

All the heat treatments were found to destroy at least some of the vitamin A potency.

Pasteurisation of milk at 161°F for 16 seconds produced the smallest, effect, while holding type was two to four times more destructive than the former, the effect being more severe in case of buffalo milk.

Boiling was responsible for much more serious losses both in cow and buffalo milk and the intensity of losses became more prominent with time for which the milk

was subjected to this treatment. Boiling for 15 minutes resulted in a loss of 23.35 percent of carotene in cow milk and 18.48 and 15.17 percent of vitamin A potency in cow and buffalo milk respectively. Losses due to simmering fell in between the two heat treatments stated above.

Examination of cow milk samples reveals that vitamin A is slightly more heat resistent than its precursor. This fact coupled with another that there is no carotene in buffalo milk explains the relatively lower magnitude of vitamin A potency losses in buffalo than those occuring in cow milk.

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CAROTENE CONTENT OF CATTLE FEEDS.

D. S. Saraswat and S. N. Singh.

Part III. The effect of drying by different methods on the carotene content of pasture grass.

It has been observed that the carotene content suffers a heavy loss during drying and subsequent storage of the cattle feeds. It is destroyed due to effect of heat, oxygen, sunlight, enzymes and bacteria. The temperature and duration of drying directly affect the extent of destruction.

Fresh, green pasture grass was collected from the college farm for the study. The sample was divided into seven lots ; one lot was immediately analysed and its carotene value used as base for other samples. The next four portions were artificially dried, three at 100.0°C for 2, 4 and 6 hours in a Hot-Air-Oven and one at 60·0°C for 18 hours in an Incubator. The remaining two portions were dried in the natural way, one in the shade at room temperature (27.7°C) and the other in the sun (mean temp. 30·0°C) on three consecutive days. All dried samples were analysed simultaneously after 72 hours of commencement of the experiment.

The results as summarised in Table I, reveal that the loss was maximum (60%) in the sun-dried sample and also was fairly high (40%) in the air-dried sample, whereas it was much less (28%) in the sample artificially dried inside an Incubator. The samples which were quickly dried inside the Oven for 6, 4 and 2 hours suffered markedly lower losses of 16, 12 and 8 per cent respectively. Stephen, *et. al*[1] and Seshan and Sen[2] reported similar, though somewhat higher, losses in fodders dried by artificial means and also made into hay in the normal way.

TABLE I.

The effect of drying by different methods on the carotene content of pasture grass.

S. No.	Heat Treatment received.	Carotene in Mg. per Kg. dry weight.	% loss of carotene
1.	Fresh green	354	
2.	100·0°C for 2 hours	324	8
3.	100·0°C for 4 hours	309	12
4.	100·0°C for 6 hours	294	16
5.	60·0°C for 18 hours	255	28
6.	Air-dried : 27.7°C for 72 hours	212	40
7.	Sun-dried : 30·0°C for 30 hours for 3 successive days	140	60

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FARM BUSINESS ANALYSIS OF 30 FARMS IN MIDHAKUR, AGRA DISTRICT, U. P.

John W. Mellor and T. V. Moorti.

The Sample.

This study is based on data collected from a stratified random sample of 30 farms from the village of Midhakur, Agra District, U. P. The list from which the sample was drawn was stratified by size of ownership unit and the various strata sampled non-proportionately.

The farms in the sample range in size from 4 bighas to 53 bighas. This range of farm sizes includes most of the land farmed in the study area. Soils were relatively homogeneous within the sample. Two-thirds of the land falling in the sample was canal irrigated and most of the remaining land can be commanded by wells.

Data were collected over the composite 1959—60 crop year with 8 interviews to each farmer spaced according to the completion of seasonal work tasks. A small sample of farms was chosen to allow time for intensive work with each farmer. This article reports only the salient features from the larger study.[1]

Determinants of Farm Earnings.

Farm Family Earnings was chosen as the most meaningful measure of success for these farms. It is the combined net return from the farming operation to the family labour, land and capital inputs. These are the resources which the typical farm family in this area controls and provides the income upon which it depends for its living. It is basically this sum which the farm operator attempts to maximize. Because of substantial variation in size of labour force among farms, Farm Earnings have also been expressed in terms of the amount per full-time worker.

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1. *The full report of the study is contained in*: *Mellor, John W. and T. V. Moorti,* **Farm Business Analysis of 30 Farms, Midhakur, Agra District, U.P., 1959—60,** *Research Bulletin* 1, *April, 1960. The Balwant Vidyapeeth, Bichpuri (Agra).*

Crop yields per acre and bighas of land per full-time worker were the key factors affecting Farm Family Earnings per full-time worker. A regression equation was computed as follows : $z = -278 + 26.3x + 10.2\ y$ (where z=farm earnings per full-time farm worker ; x=bighas per full-time farm worker and y=yield index). R=.64 and R^2=.41[2]. This indicates that these two factors alone when expressed in a linear additive function explain nearly half the variability in farm earnings per full-time worker. A linear function of this type was fitted because it was simple to compute and inspection of the data suggested little improvement of fit from a more complex function. Projection of this precise form beyond the range of this data would not be logical.

The limited local land market places bighas per man largely beyond the control of these farmers. But, crop yields, at least averaged over a period of years, are within their potential control. The importance of yields is further emphasized in Table I. Farms falling in the high third in yields had earnings of Rs. 643 per full-time worker which is about 50 percent higher than the income of farmers falling in the low third in yields. This is despite the fact that the high yield farms had only two-thirds as much land per full-time worker as the low yielding farms.

TABLE I

Factors associated with different Crop yield levels, 30 Farms, Midhakur, Agra, U. P., 1959-60.

Group	Yield Index		Bighas operated per permanent Farm Worker	Bighas per Bullock	Percent of land canal irrigated	Farm Earnings per Full-time Farm Worker
	Range	Average				
High third	69-97	76	7.9	8.5	76	643
Middle ,,	53-65	59	8.4	9.7	43	575
Low ,,	34-39	42	12.2	10.1	71	453
Average	34-97	59	9.5	9.5	67	557

The importance of yields in determining the level of farm incomes indicates the basic unity of national policy for increased agricultural production and national policy to raise the level of farm income.

2. This suggests a marginal value product of land of Rs. 263 per bigha. This gives a range in value per bigha of Rs. 580 to Rs. 880 corresponding to interest rates of 5% to 3%. Such interest rates seem reasonable for land investment. This price range seems consistent with the few sales which have occurred in the past several years.

The yield index used is a composite yield index for the various crops based on the top yields as 100. Loosely interpreted a unit on the yield index is equivalent to about 2 maunds of grain per bigha.

In more highly developed agricultures yield alone does not have as direct and important an influence on farm earnings. With increasing development yields become more and more a function of the use of purchased inputs. In such circumstance cost control and choice of optimal levels of use of these inputs becomes increasingly important. In the area of this study differences in yields seem to be largely due to differences in the use of fixed, low opportunity cost imputs, in particular family labour. Purchased seed, fertilizer, insecticides etc. are still relatively unimportant. As these imputs become more popular increasing attention will have to be paid to determining optimal levels of use of these inputs.

Factors Affecting Yields.

Crop yields are highly variable within this sample. The top yield index is nearly three times the lowest. In wheat yields the top yield of 20 maunds per acre is four times the lowest, with a fairly even progression from top to bottom. Farm to farm differences in soil and irrigation water supply appear to be well distributed through the various yield strata.

Of the factors studied, amount of land per full-time worker is easily the most important yield influencing factor (Table I). A regression equation was computed $y = 72.2 - 1.4\ x$; where y = yield index and x = bighas per full-time farm worker ; $r = -.46$.

Because of the nature of the yield index some additional interpretation of these figures is given. For each increase of 1 bigha per permanent farm worker, yields can be expected to decline 1.4 percent from the top yield in the sample. Thus, if bighas per permanent farm worker increase from 6 to 12, yields may be expected to decline by an amount equal to 8.5 percent of the top yield. Expressed in terms of wheat that means a total reduction in yield of 1.6 maunds per bigha valued at Rs. 29. Thus, in a change from 6 bighas per man to 12 bighas per man a total reduction in production of 19 maunds valued at Rs. 342 can be expected as compared with the 12 bighas being split into two parts with a permanent farm worker for each part. Considered as the segment marginal product of labour this is a substantial figure. It is equal to about two-thirds of a full-time hired labourer's annual wages and is similar in level to the average return per full-time worker on the one-third of the farms with the lowest returns.

A scatter diagram of this relationship reveals that none of the farms with a large number of bighas per worker have high yields. while those farms with few bighas per worker have a wide range of yields. Thus, small amounts of land per person certainly does not guarantee high yields.

The measure bighas per worker reflects (a) the availability of labour for performing jobs well and on time and (b) the incentives to press or higher yields and incomes

as reflected in the assets and earning power of the farm. Observation of these farms suggests that the incentives factor is in fact the more important of the two.

Variation in acceptance of improved practices such as improved seed, inorganic fertilizer, green manuring etc. seems to explain very little of variability amongst farms in crop yields. This is so largely because these practices were so rarely applied as to eliminate any opportunity for them to show significantly in the statistical analysis. In terms of attitudes and capital availability a majority of the farmers in this sample seem ready for these innovations. The limitations to acceptance seem to be first problems of supply and second problems of adequate, technically competent demonstration. In regard to supply, farmers comments concerning seed, plus the technical problems in the common method of seed multiplication suggest that a reliable source of good seed is not available.[1]

Deficiencies in seed quality lessen the returns to fertilizer and other inputs. A program for supplying certified seed or some approximation to that should yield high returns. Farmers expressed considerable interest in improved seed despite generally unfavourable past experience.

Program for Increasing Yields.

A program to increase yields should attack on two lines (1) improving the general standard of husbandry within the confines of traditional methods and (2) introducing improved practices and inputs.

A program to improve the general standard of husbandry might logically approach from three points. Firstly, increasing the supply of attractive consumer goods would serve as a spur to incentive. The evidence that many of the low yield farmers are those with large holdings, and a strong asset position suggests the need for additional incentives beyond those normally part of the village standard of living. This of course does not mean that these farmers will spend all their incremental incomes on these new consumer goods. Added incentive to produce income would likely result in increased investment of a portion of increments to income.

A second means of increasing incentives is through the exhortive programs of community development. Such programs, providing prestige to high yield farmers could well have a useful effect. Emphasis on such programs should however be on farm wide yields rather than on simple acceptance of practices or yield competitions on small, specially nurtured plots.

Combined with a program of increased incentives should be study of the specific aspects of traditional practices which contribute to high yields. This

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1. *On this point see also* : *The Ford Foundation, Agricultural Production Team,* **Report on India's Food Crisis and Steps to Meet It.** *Government of India, 1959, P. 60.*

information should be used (a) in directing extension efforts and (b) as evidence in convincing farmers of the efficiency of certain practices.

The second prong of an effort to raise yields lies with the introduction of improved inputs and production practices. This program is importantly related to the factor of improved husbandry. It is likely that substantial response to improved inputs requires that a generally high standard of husbandry be maintained. Thus widespread response to improved methods will require improving the standard of husbandry of those currently low.

The first requisite of a program for greater acceptance of improved methods lies with solving the current problems of supply of good seed and fertilizer at the time and place needed.

The second requisite is demonstration of these improvements under village conditions, pointing out the requisites for successful response and the factors which may lead to failure. In particular the joint relationship between seed and fertilizer should be clarified.

Another input which might give a production response is that of improved implements. The correlation between bighas per man and output suggest the potential for a response to improved tillage equipment. Little acceptance of improved implements is evident. It may well be that research is needed to improve these implements before a supply and demonstration program will succeed.

Land Use.

Land is fully used during the rabi season and farmers provide a logical rational for the present cropping pattern. Whether or not they have fully adjusted to such dynamic factors as changes in some price relationships, the enlarged local milk market etc. is not clear from this study.

About half of the land on the farms in this study was fallow during the kharif season. Fuller use of this land probably requires a research program including several academic disciplines.

Yield uncertainty is very great in the case of most currently available kharif crops. The surest crop now available is probably jowar grown for fodder. Development of greater production of this crop requires :

1. Research on improved methods of storage, including :
   (a) Methods of making silage, such as bullock driven chaff cutters.
   (b) Methods of storage of silage suited to the climate and raw materials of this area, such as bunker type silos.
2. Research on the milk production response from feeding jowar fodder and means of increasing this response.

3. Fertilizers and irrigation practices needed when a crop such as jowar is grown prior to wheat.
4. Use of improved implements to speed land preparation when wheat must be sown after a Kharif crop. Associated with this is the question of optimal planting dates for Rabi crops.

A second area of research lies with the development of alternative Kharif grain crops such as improved sorghums.

Level of Farm Incomes.

Farm Family Earnings in this study averaged Rs. 1310 per farm. One-third of the farms averaged over Rs. 1500 per farm (Table II). In addition these farmers had housing, fuel, greens and the value of milk over depreciation and grain fed to milk animals.[1] On the basis of the data in this study and other studies it was estimated that the families in this study averaged some Rs. 200 per family per year beyond what is needed to provide the basic standard of living required by village social and physical conditions. This is not a large figure, but it is significant by the standards of the capital requirements for innovations in the early stages of development of these farms.[2] It appears even more significant when it is realized that a substantial number of these farmers have more than the average income that several of those with low incomes have larger than average land holdings.

TABLE II

Distribution of farm family earnings per full-time worker

Income Range in Rupees	Number of Farms
Under— 500	4
500—1000	7
1000—1500	8
1500—2000	7
2000—and over	4
Total	30

1. *Due to failure to collect the necessary data neither the value of milk production nor of fodder fed milk animals is included in Farm Family Earnings.*

2. *See for example :* **Indian Cooperative Union, Rural Development and Credit Project, Evaluation Report,** *New Delhi, January, 1960.*

The report supplies data on a supervised credit program near New Delhi in which loan amounts were "not determined by a maximum limit, but were decided on the basis of the need of the cultivator and his ability to repay from increased production." The average size of short term loans for 1957—58 and 1958—59 Rabi were Rs. 40 and Rs. 34 respectively. The largest loan was Rs. 225. Medium term loans for purchase of bullocks, buffalo and farm equipment averaged Rs. 368.

These data suggest that the agricultural population has the financial resources to finance a substantial proportion of the capital improvement needed for increasing production. This capital may be viewed in two parts, (1) that publicly financed and (2) that privately financed. Private incomes of course provide funds for both.

The data suggest that the income levels of the cultivators in this sample, which are representative of the area, are sufficient to support a higher level of taxation. Such a tax program would not necessarily be politically unacceptable if it emanated from the now to be strengthened panchayats, and the proceeds were used for local improvement. Income increasing improvements such as roads and schools might be particularly acceptable. Evidence in this study showing lower yields on farms with a larger number of bighas per man and the suggestion that this may be related to incentives suggest that a graduated land tax might serve this purpose well.

These data also suggest the potential for financing agricultural improvements internally if the farmers are convinced they will pay. A substantial proportion of the land could be fertilized at recommended rates for a capital sum of Rs. 200 per farm. The extra cost of improved seed over ordinary seed is insignificant compared to this sum. Likewise a good start on equipping with improved implements could be made with such a sum. In this regard it should be pointed out that every farmer in the sample owned a chaff-cutting machine, requiring 50 to 100 rupees outlay. This is not a traditional piece of farm equipment and it is largely a labour saving device. It costs more than an improved plow and harrow together. In regard to more expensive machinery, all of the farmers owned or were in a partnership for a Persian wheel, while 11 rented one. This is a large number of farmers making use of equipment costing about Rs. 500 per set. Thus it would appear that problems of credit and low incomes are not presently the limiting factors if acceptance of presently useful types of innovation. The problem is one more of physical supply of inputs and demonstration, and in some cases developmental research.

The substantial potential for increasing yields and hence incomes suggests an even greater future potential for financing both private and public capital expenditure from farm earnings.

The above statements are not meant to belittle the problem of rural poverty. The data do suggest that the problems of extreme rural poverty and increasing agricultural production may be separate problems. Those who farm the bulk of the land are not in general the poverty stricken members of rural society.

Land Partnership and Rental Arrangements.

An imperfect land market, high social value attached to owning land and the sense of security of land ownership all combine to maintain a situation of large numbers of small holdings many of which are too small to make effective use of

farm capital. Although the major portion of the land is in units approaching optimal size for the use of currently employed capital farms, a significant minority of the land, say from 20 to 30 percent falls in units which cannot make full use of farm capital.

Land rental and partnership arrangements provide a system for combining these holdings into more nearly economic size units. Although one-quarter of the ownership units in this study were under 10 bighas in size, the smallest operating unit was 12 bighas in size. Four of the farmers significantly increased their operating unit through Batai (share cropping) systems and four through partnership arrangements (Table III). These arrangements considerably increased the amount of land per bullock pair and per full-time worker. Hence the income potential was increased.

TABLE III

Factors associated with different "rental" systems

Type of Arrangement	Number of cases	Bigha owned	Bigha rented	Bigha operated	Bigha per worker	Bigha per bullock	Yield index
Batai	4	13.1	1.6	14.7	—	—	—
Batai	4	8.5	6.0	14.5	4.4	6.5	67
Partnerships	4	5.6	15.2	20.8	8.8	10.4	49
30 Farm Average	30	21.3	3.0	24.3	9.5	9.5	59

Although the sample is small, the data in this study suggest that much of the potential value of the partnership arrangements may be lost through low yields. In the case of Batai arrangements the yield index is almost exactly at the level predicted by the regression equation expressing yields as a function of bighas per man. However the yield index for the partnership arrangements is some 10 points lower than the predicted level. Partnership arrangements seem to be subject to a number of disagreements particularly in regard to sharing of the work load and dividing the production. This element of instability and uncertainty reflects itself in the quality of job performance and hence in yields. The potential gains from such partnership arrangements are substantial. Realization of the full potential will require development of institutional devices for increasing their stability. It is likely that further research and a well directed extension program could make useful progress in this direction.

STUDIES IN VICIA FABA LINN.

Its germination, development, morphology and effect of photoperiodism, colchicine and sulphanamide treatment.

Ramnuj Dayal Goyal.

Vicia faba Linn. is an important vegetable crop of the family **Leguminosae.** It has been studied here because of the existence of small amount of cytological and hybridization work on it.

Germination is hypogeal and takes 6—8 days. The cotyledons remain attached to the plant up to flowering time. Type I, showed 86% and 74%, Type II 96% and 86%, type III 62% and 53% germination in the pots and field respectively. The radicle emerges out on the third or fourth day, and the branches appear from the tap root near the ground level by the ninth day.

On the main stem branches arise only in the axil of first, second and third leaves.

The number of leaves on the main stem of the plant generally ranges from nine to twelve only, during the vegetative cycle of the plant which lasts between 52—59 days.

Regeneration in *Vicia faba* can be affected from root tips, seedlings and total root system.

Buds measuring. 2 – 3 cms. in length take 14—18 days to bloom.

Microspore mother cells undergo meiosis between 9.20 A. M. and 4.30 P. M.

Fruit setting in self pollinated plants was found to be 16% in the windsor variety and 94% in the Indian variety.

The stigma remains receptive between 7 A. M. and 5 P. M. but the maximum receptivity is observed at about 9.45 A. M.

The plants start flowering after 70 – 76 days of sowing. The flowering period of the plants ranges between 16—27 days.

Plants which are subjected to continuous light illumination are considerably taller and show 12 days of earliness in flowering.

Sulphanamide treated seeds showed delayed germination, were shorter in length, the root system was very weak and flowers were smaller with a disturbed arrangement of paplionaceous corolla.

Wall layers of a young anther consist of an epidermis, the endothecium, a middle layer and uninucleate tapetum. As the endothecium develops it crushes the epidermal cells so that it finally occupies the outer most position of the anther wall.

Microspore mother cells undergo heterotypic division resulting in the formation of both isobilateral and tetrahedral microspore tetrads.

The pollen grains of *Vicia faba* showed maximum germination in 7.5% sugar-agar medium.

The pollen tube bears the vegetative nucleus at its tip. The two male nuclei may be oval, sickle shaped or rod shaped. Branched pollen tubes are also met with.

Ovules are anatropus and bitegmic. Archesporium is hypodermal in nature.

Generally a single megaspore mother cell but some time 2 also are observed in an ovule.

Megaspore tetrads are linear and the chalazal megaspore functions.

Embryo sac development follows Polygonum type.

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MORPHOLOGY OF COMPANUL A CONESCENS WALL.

C. Joyce Mathew

The present work was undertaken as there was some controversy regarding the systematic position of the family Campanulaceae. Tracing out the exact origin of micropylar and chalazal haustoria, which is dubious so far, has also been one of the aims.

Flowers are dimorphic and arise in panicled cymes. One of them is of perfect type while the other lacks corolla and stamens. Floral formula of perfect flower is K (5) C (5) G (3)

Floral parts arise in acropetal succession of sepals, petals, stamens and carpels.

A ring of vascular bundles at the base of the flower soon forms two rings, the inner of which supplies the placenta while the outer ring, after it has traversed the ovary, breaks up into branches that enter the sepals, stamen and style. Each sepal has three vascular bundles, and the gamopetalous corolla has five or more as a result of further branching while there is only one bundle for each stamen and three are present in style.

Wall layers of a young anther consist of the epidermis, a spirally thickened endothecial layer, single middle layer and the tapetum which is uninucleate.

Pollen grains are round and bear a large tube nucleus and two small male nuclei.

Mature ovule is anatropous and unitegmic. The chalazal megaspore functions and by Polygonum type of development gets converted into the Embryo Sac.

The endosperm is cellular and develops after Scutellaria type. Both micropylar and chalazal haustoria were observed and of the two former is more conspicuous.

The Embryo develops after Solanad type. The terminal cells of the proembryo develop into the embryo proper. Suspensor, that is a means for conduction of food material consists of seven or occassionally more cells at its early stages.

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MEASUREMENT OF THE VERTICAL MOVEMENT OF THE IONOSPHERIC LAYERS FROM THE OBSERVATIONS OF THE PERIODIC FADING OF RADIO-SIGNALS.

R. N. Singh

Abstract :

Periodic fading on various short wave bands have been observed for a number of years at different hours and months, of the year. Electronic concentrations in the Ionosphere at the hours of observation of the fading patterns have been calculated and consulted from the publications of the Research Department, All India Radio, Delhi. The rate of vertical movement of the ionospheric layers during the observations of fading pattern have been calculated from the automatic records of fading patterns. The method of calculation of the rate of movement of the ionospheric layers has been discussed.

Introduction :

In earlier communications by Banerji and Singh (1949) and Singh (1952), it has been discussed that periodic fading is found to occur distinctly under two different conditions of the ionosphere namely (1) when the electronic density in the ionospheric layer is fairly high to permit double reflections of the wave on a particular frequency, and the layer or layers from where the reflections are taking place, possess vertical movement ; and (2) when the electronic density in the ionosphere is so low as to be just sufficient for single reflection of the wave between the transmitting and receiving stations (Appleton and Beynon, 1947) Periodic fading under the first condition is caused by the interference between two waves either from the same or two different layers and is usually quick and peaky. Periodic fading under the second condition is due to the interference between the ordinary and extraordinary ray reflections of the split wave from the ionosphere due to magneto-ionic effect. They have been called 'magneto-ionic fading.' Such fading patterns being usually slow and smooth are also called 'slow and smooth periodic.' The present communication is

intended to show a method for the calculation of the rate of movement of the ionospheric layer from the Periodic fading patterns of the first type namely peaky periodic.

Peaky Periodic Fading Patterns :

Typical examples of this type are collected in table I, in which columns 1, 2 and 3 contain the serial numbers of figures, date and time in I. S. T., and the wave bands respectively. Column 4 gives the electronic densities existing in the F_2—region at the time of observation. Column 5 of this table contains the calculated electronic densities required for double reflection from F_2—layer for various frequencies. The calculated and the observed rates of movement of F_2—layers are given in column 6 and 7 respectively. It will be clear from the table that the occurrence of peaky periodic fading is undoubtedly accompanied by (1) high electronic concentration in the ionosphere to the extent of and above that needed for double reflection of the wave used and (2) vertical movement of the ionospheric layer or layers from which the reflections are taking place. The rate of movement of ionospheric layers calculated from the fading patterns has been compared with observed variation of the height of the layers. The method of calculating the rate of vertical movement of the ionospheric region is given below :

Method of calculating the rate of vertical movement of the ionospheric region from the peaky periodic fading patterns.

Suppose the ionospheric layer has moved vertically upwards by an amount dx. Due to this movement the paths travelled by both singly and doubly reflected waves will increase. The increased path length dP of singly reflected wave will be given by the expression,

$$dP = 2\,dx\,\operatorname{cosec} \alpha \quad \ldots\ldots(1)$$

where α is the angle of radiation for the singly reflected wave.

For the doubly reflected wave, the increased path length dP^1 will similarly be given by

$$dP^1 = 4\,dx\,\operatorname{Cosec} \beta \quad \ldots\ldots(2)$$

where β is the angle of radiation for the doubly reflected wave. Now for transmission between Delhi and Banaras, the average observed values of α and β for F_2—layer are about 47° and 59° respectively. Substituting these values in equation (1) and (2), we get—

$$dP = 2\,dx \operatorname{Cosec} 47^\circ = 2.74\,dx$$

$$\text{and } dP^1 = 4\,dx \operatorname{Cosec} 59^\circ = 4.68\,dx$$

The total path difference between the singly and doubly reflected waves brought about by the vertical movement dx of the ionospheric region will, therefore, be given by,

$$dP^1 - dP = 1.94\,dx$$

Now if λ is the wavelength used during the observation of fading patterns, and if n be the number of maxima observed per minute in the obtained periodic fading pattern, we have,

$$1.94\,dx = n\lambda$$

or $$dx = \frac{n\lambda}{1.94}$$

If λ is measured in metres, the velocity V of the F_2— region can be expressed as,

$$V = \frac{n\lambda}{1.94} \times \frac{60}{1000} \text{km/hour}$$

or $$= 0.031\ n\lambda \text{ km/hour} \quad \ldots\ldots(3)$$

With the help of this equation, the rates of vertical movement of F_2—layer, were calculated from the fading patterns by substituting the values of wavelength and the number of maxima per minute contained in the observed periodic fading patterns figs. (1—5). On 25 metre bad for transmission from Delhi, the number of waves (fig. 1) per minute were 6.8.

The velocity or the rate of movement of the F_2—layer $= 0.031 \times 6.8 \times 25$.

V=5.26 km/hour, while the observed value as shown in column 6, of the table is 7 km/hour.

The rates of movement of the ionospheric layer calculated from the periodic fading shown in figs. 1—5, by the above method, are shown in column 6 of the table, and observed values for the same are shown in the 7th column for comparison. It will be seen that there is close agreement between the calculated and the observed rate of vertical movement of the layer.

TABLE I

Fig. Nos.	Date and time in I. S. T.	Wave band	Existing electronic densities in the F_2—region in electrons/cc.	Electrons/cc. required for double reflection from F_2—layer	Rate of movement of F_2—layer calculated from fading patterns in km/hour.	Observed rate of movement of F_2—layer in km/hour.
1.	2-5-46 0855 hours	25m—Delhi	1.41×10^6	1.30×10^6	5.3	7
2.	11-4-43 0801 hours	,,	2.01×10^6	Between 1.20×10^6 and 1.30×10^6	9.0	10
3.	23-5-46 1735 hours	41m Delhi	1.78×10^6	Between 0.46×10^6 and 0.48×10^6	14.8	13.5
4.	17-5-46 0750 hours	,,	0.90×10^6	,,	9.8	10
5.	23-5-46 1915 hours	,,	$1{\cdot}54 \times 10^6$	,,	20.9	18

Fig. 1

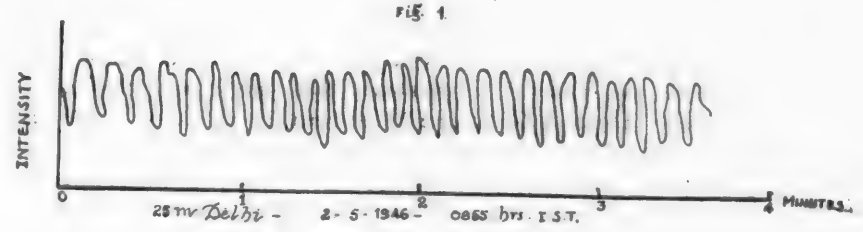


Fig. 2

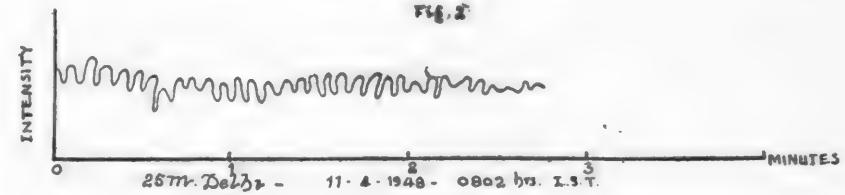


Fig. 3

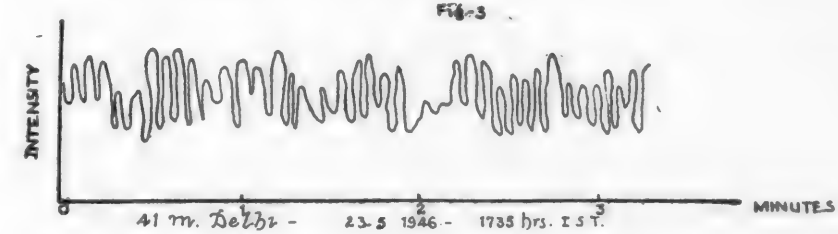


Fig. 4

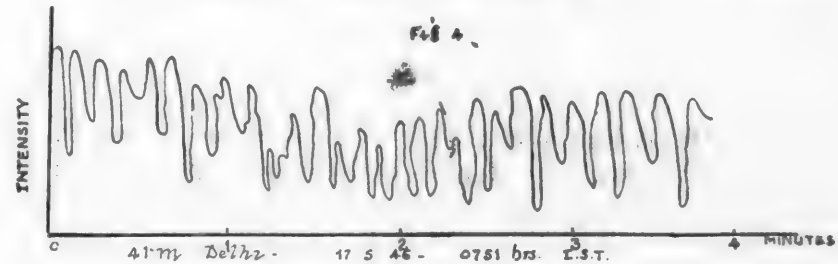
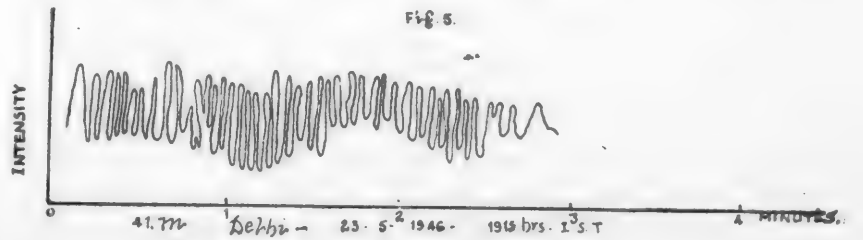


Fig. 5.



Thus these types of fading patterns (peaky-periodic) may go to predict the suitability of the ionospheric condition for radio-communication on the one hand and on the other, provide an easy method for calculating the rate of movement of the ionospheric layer. It may, however, be mentioned that such slow vertical rate of movement of the layer as can easily be calculated from the fading patterns of this type, cannot be determined experimentally by the usual 'pulse method' with cathode ray oscillograph, as even the most sensitive instrument employed in this method gives the rate with an approximation of $\pm$ 10 km per hour, whereas the rate of movement of the ionosphere has sometimes been found to be as low as $\pm$ 5 km/hour by this method. It may be added that in order to ascertain double reflection from F_2—layer for the formation of peaky periodic fading of radio signals, the approximate angles of arrival of the down-coming waves were experimentally measured.

Conclusion :

Thus this communication has discussed the peaky periodic fading patterns and the method for the calculation of the vertical movement of the ionospheric layers for peaky periodic fading patterns. This method claims simplicity and application for smaller movements of the ionospheric region.

Acknowledgments :

The author feels greatly indebted to Dr. S. S. Bannerji D. Sc., for suggestions and criticisms. The author wishes to record his grateful thanks to Dr. R. K. Singh, D. Ed., Principal, B. R. College, Agra for his encouragement for research. Lastly, he feels grateful to the Research Department, All India Radio, Delhi for supplying the ionospheric data.

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NOTES

PROGRESS REPORT OF THE SCHEME ON THE NUTRITIONAL REQUIREMENTS OF BUFFALOES

Buffaloes—a unique asset to the country :

Buffaloes occupy a unique position in the list of country's livestock assets. Their role as a producer of 'protective' foods—the essential prerequisites for raising the nutritional level of our human population cannot in any way be ignored. Although numbering less than cows in population, they contribute more than 50 percent of the country's total milk output, which itself is an eloquent testimony of their great economic worth. Besides, they are a significant source of meat to a certain section of the community. However, the usefulness of their adult male progeny for draft purposes becomes limited due to their characteristic slowness. Nevertheless being comparatively cheaper they are preferred and valued fairly high for dragging heavy loads and puddling wet lands for rice cultivation. Furthermore their ability to convert coarse roughages more efficiently into milk with high fat content and to withstand varied tropical climate conditions adds to their significance and induces for their fuller exploitation and better performance.

Scientific feeding—a key to swift economic livestock improvement :

Scientific feeding ranks at the top amongst the manifold requisites for affecting improvement in the livestock. It's the tool by which the inherent potentialities of a well bred animal are fully displayed and maximum production with minimum of over feeding is attained. But it is rather alarming that the information in respect of the scientific feeding of buffaloes is very scanty and the so called scientific feeding of this important class of ruminants in organised dairies is based on the requiremental recommendations for the cows under exotic conditions with certain allowances which may or may not hold true. In addition, the present chronic scarcity of feed stuffs accompanied by their high prices does not permit a venture of this sort to continue anymore and further presses the urgency for its solution. Judicious feeding based on the actual requirements of the animal is one of the feasible wayouts to this tangle.

Aim and brief history of the project :

In view of the immense significance of the scientific feeding based on requirements of animals, a research project which aims at working out the nutritional requirements

of buffaloes for various purposes, viz., requirements for maintenance, growth, milk, work and meat production was submitted to the Indian Council of Agricultural Research.

The Indian Council of Agricultural Research sanctioned the scheme at the first instance for a period of three years with effect from April, 1955 to determine only the maintenance requirement of Protein, Calcium and Phosphorus. It granted Rs. 84,050 to meet out the expenditure on the project. In the light of the nature of work, being fundamental, the Council also recommended to take up only the minimum and maintenance requirement of protein during the first year.

Set up in a nut-shell :

The scheme is stationed at College Dairy Farm at Khandari, where it has a metabolic shed and a small laboratory for analytical work. The project has provison for twenty-four adult male experimental buffaloes, three mazdoors, two attendants, two Research Assistants and an Assistant Research Officer. Shri B. S. Gupta whose sevrices have especially been procured from the Indian Veterinary Research Institute, Izat Nagar by the Council, is working as the Assistant Research Officer, and Shree V.N. Bhargava as the Senior Research Assistant. There has been no Junior Research Assistant for the last one year.

Progress of the work :

The start of work ought to have synchronised with the date of the sanction of the scheme but the actual experimental work could not be started till June, 1958 due to delayed appointment of the Assistant Research Officer and other numerous technical hurdles. Soon after the joining of the Asssistant Research Officer experiments for determining the Minimum and Maintenance requirements of protein were taken up.

Minimum protein requirement which draws the base line as minimum level of protein intake for maintenance was estimated on the basis of the Endogenous Urinary Nitrogen Excretion. For this eight healthy adult male buffaloes almost uniform in all respects, viz., age, body, weight and feed consumption were fed on an energy adequate but low protein ration consisting of Sugar, Sago, Oil Mixture, Salt Mixture and Wheat Bhusa as recommended by Kehar, Mukherjee and Sen (1943). Their daily nitrogen excretion in urine was determined. The constant minimum value of daily urinary nitrogen so attained, gave the Endogenous Urinary Nitrogen Excretion.

Excretion of metabolic faecal nitrogen per day was also determined while the animals were kept on the above low-protein diet. A modification of the Boas Sieve method (1932) was adopted for the determination of metabolic faecal nitrogen which

is essential for estimating the biological value of feed protein and the protein requirement for maintenance.

After the estimation of endogenous urinary nitrogen (E. U. N.) and metabolic faecal nitrogen (M. F. N.), experiments on the maintenance requirement of protein have been started in February, 1959 and are still continuing. For this almost identical groups of adult male buffaloes are being maintained on different levels of digestible crude protein intake. Each level of digestible crude protein intake forms one experimental group. Intake of digestible crude protein has been kept to be the only variable. The ration is otherwise uniform and adequate in all respects. Quarterly metabolic trials are conducted to study the nitrogen balances in the different groups. Haematological studies, observations on respiration, pulse and temperature of the animals at regular intervals and weekly body weights of the animals are also recorded. The lowest level of digestible crude protein intake which ensures nitrogen equilibrium, normal health and body weight of the animal over this long period will represent the nitrogen requirement for maintenance. Five balance trials have been completed so far, and this aspect of study will soon be over.

Immediately after this, investigations on Calcium and Phosphorus requirements for maintenance will be commenced. Both will be determined individually by balance studies. The lowest levels of Calcium and Phosphorus intakes which guarantee Calcium and Phosphorus equilibrium respectively over long term period will represent the Calcium and Phosphorus requirement for maintenance.

Financial Skeleton :

As pointed out earlier, the scheme is solely financed by the Indian Council of Agricultural Research. An yearwise expenditure incurred on the project is presented below :—

	1956—57	1957—58	1958—59	1959—60
(1) Recurring Expenditure	8,935.19	11,437.33	22,455.61	27,658.52
(2) Non-recurring Expenditure	15,448.69	Nil	2,587.98	Nil
Total	24.383.88	11,437.33	25,043.59	27,658.52

An amount of Rs. 88,523.32 has been spent till 31st March, 1960, and Rs. 33,860.00 have further been sanctioned for 1960-61. The College has contributed towards this project in its own way by providing metabolic stalls, laboratory and finally the Honorary Services of the Officer-in-charge.

It would not be out of place to mention that results achieved during 1958-59 have been adopted by the Animal Nutrition Committee of the I. C. A. R. in April, 1960. Extract of the remarks of the Committe states, "The Committee adopted the report and appreciated the useful work completed so far. The Committee desired that this centre after completing observations on maintenance requirements should take up work on growth and milk production in buffalloes." In this respect the proposed plan of growth requirement at a cost of Rs. 1,82,634 has already been submitted.

In the end, to sum up we say that this scheme has yielded valuable information to build up our own literature and promises to yield more useful data of practical utility in near future.

We highly appreciate the interest shown by the Indian Council of Agricultural Research, its expert bodies and its Officers particularly Dr. N. D. Kehar, M. Sc., Sc. D.—the Chairman of the Animal Nutrition Committee for personal guidance and advice.

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S. N. Singh,
Officer Incharge.

A LIST OF THESES SUBMITTED TO THE AGRA UNIVERSITY THROUGH THE B. R. COLLEGE IN 'BOTANY' (TILL 1959)

CLASSIFICATION OF THE THESES

(At post graduate level)

Class No.	Title of the Class	No. of Theses written
1	All the Theses are on Embryology	21
	(At Ph. D. level)	
I	Plant Physiology	2
II	Morphology	4

The details of the theses are given in the following pages.

S. N.	Title of the Theses	Year
1	Studies in the family Leguminosae subfamily Papilionatae. (In two parts). 1. Morphology and life history of *Lens esculenta*. Moench. 2. Study of pollen, morphology and artificial germination of Pollen grains in *Crotolaria juncea* Linn.	1949
2	Studies in *Foeniculum vulgare*, Mill. (Morphology, anatomy, floral biology and pollination with life history of the plant.	1949
3	Studies in *Vicia faba* Linn. (Germination, development, morphology, intervarietal crosses as well as effect of photoperiodism, colchicine and sulphanilamide treatments).	1949

S. N.	Title of the Theses	Year
4	Morphological and Embryological studies in *Cucumis* melo Wild and *Corriandrum sativum*.	1949
5	A contribution to the weed flora of Agra with special reference to Weeds associated with wheat crop.	1950
6	Studies in *Eruca sativa* Mill. Morphology, life history and sterility in *Eruca sativa*, Mill.	1951
7	Studies on the life history of *Trichosanthes anguina* Linn. and *Trichosanthes dioica* Roxb.	1951
8	Studies in the life history of *Solanum melongena* Linn., *Asphodelus tenuifolius* Cav., *Anona squamosa*, Linn. and *Anona reticulata* Linn.	1951
9	Studies in *Lagenaria vulgaris* Seringe. (Morphology, Floral Biology, and Embryology).	1951
10	Morphological and Embryological studies of *Hedera nepalensis* K. Koch. and *Luffa aegyptiaca* Roxb.	1952
11	Morphological studies in the Asclepiadaceae. Organogeny of flower and gametogenesis in *Asclepias curassavica*, L. and *Cryptolepis Buchanani*, Roem. and Sch.	1953
12	A contribution to the Floral anatomy, Embryology and seed structure of *Reseda odorata*, L. (Mignonette).	1953
13	Morphological studies in the Rubiaceae. Part I. Organogenesis and Floral anatomy of *Mussaenda luteola* Delile., Part II. Gametogenesis and Fertilization of *Stephegyne parviflora* Korth.	1954
14	Effects of certain synthetic auxins and an Anti-Auxin on Vernalization in *Brassica Compestris. L.*	1954
15	Morphology of *Dicentra Scandens* Walp.	1956
16	Morphological studies in *Aristolochina Indica* Linn.	1956
17	Morphology of *Nannorrhops ritchieana* H. wendl.	1957
18	Morphological studies in *Euchlaena mexicana* Schrad.	1958

S. N.	Title of Theses	Year
19	Morphology of *Campanula canescens* Wall.	1958
20	Morphological studies in *Oenothera rosea* Soland.	1958
21	Morphological studies in *Psamogeton*.	1959

THESES AT Ph. D. LEVEL

S. N.	Title of the Theses	Writer	Year
1	Anatomical studies into the mechanism of Vernalisation.	Shiv Chandra Chakravarti	1951
2	Morphological studies in some parasitic angiosperms of the Santalaceae.	R. L. Paliwal	1954
3	Studies on Drought Resistance in Wheat and Barley.	M. M. Singh	1957
4	Morphological studies in some members of the family Pedaliaceae.	Satya Pal Singh	1958
5	Stucture and Development of Seed in Euphorbiaceae.	R. P. Singh	1959
6	Studies on Endosperm and development of seeds in cucurbitaceae and some of its related families.	Dalbir Singh	1959

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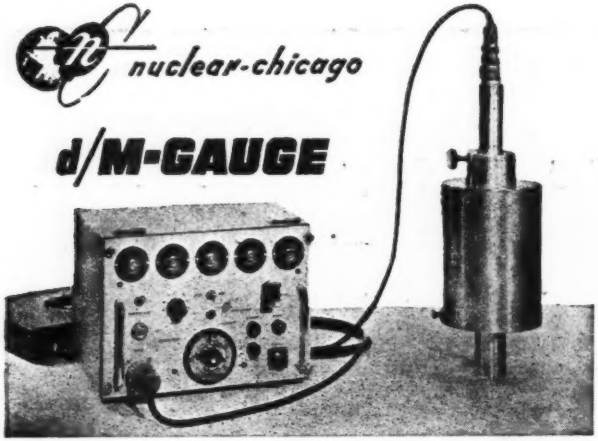

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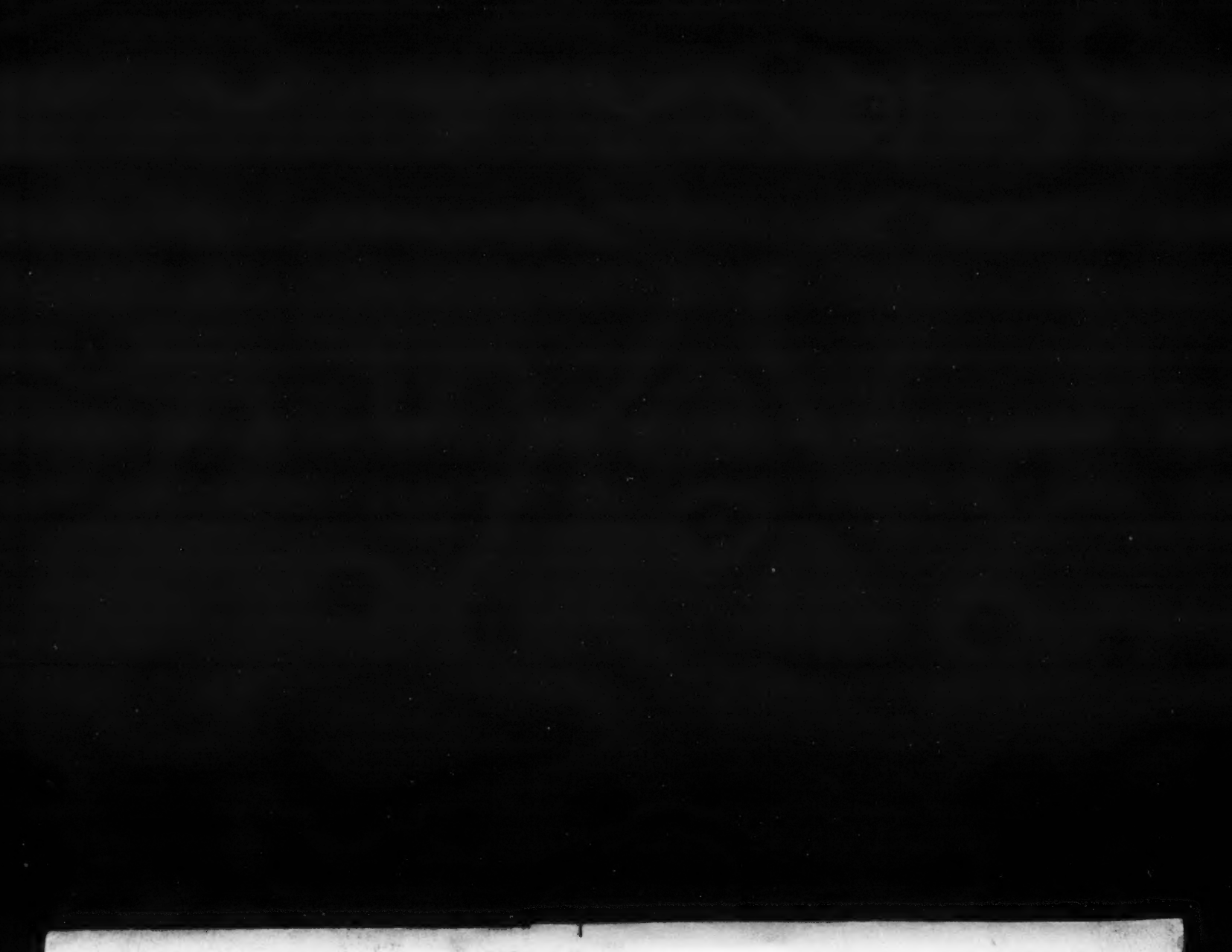
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